Engineering With Nature for Sustainable and Resilient Water Resources Infrastructure

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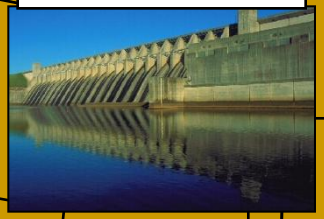
US Army Corps of Engineers
BUILDING STRONG®

USACE Civil Works Value to the Nation

Recreation areas:
370 M Visitors/yr
Generate $16B in economic activity, 270,000 jobs

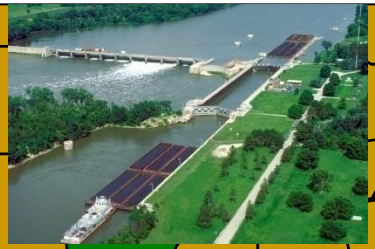
#1 Federal Provider
Of Outdoor Recreation
54,879 Miles Of Shoreline at USACE Lakes

¼ of Nation's Hydropower: $1.5B + in power sales



Stewardship of 12 Million Acres Public Lands

12,000 miles of Commercial Inland Waterways transport goods at ½ the cost of rail or 1/10 the cost of trucks



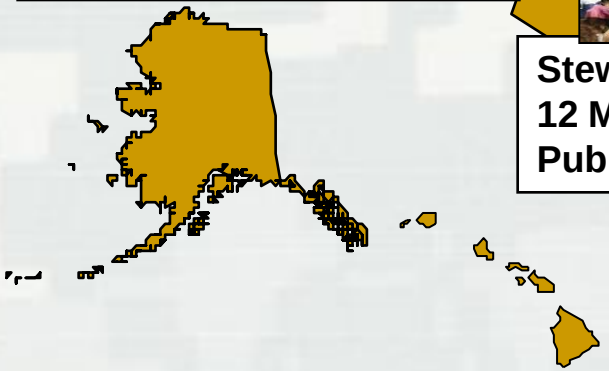
926 Shallow & Deep Draft Harbors

~14,500 Miles of Levees

Emergency Operations

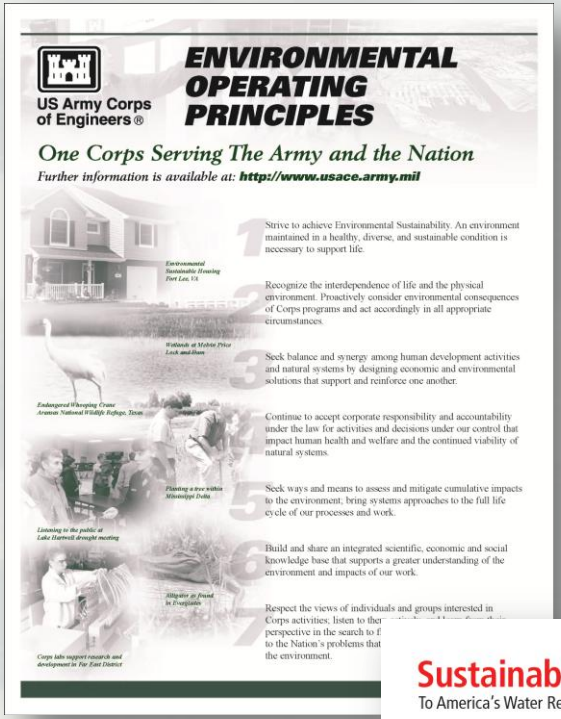
Regulatory Responsibilities

137 Major Environmental Restoration Projects



Ports & Waterways Convey > 2.37 billion Tons Commerce
Ports Provide Strategic Deployment Capability
Harbor Maintenance Trust Fund collects $1.7 billion revenue

Advancing USACE Practice



Vision: "Contribute to the strength of the Nation through innovative and environmentally sustainable solutions to the Nation's water resources challenges."

Goals:

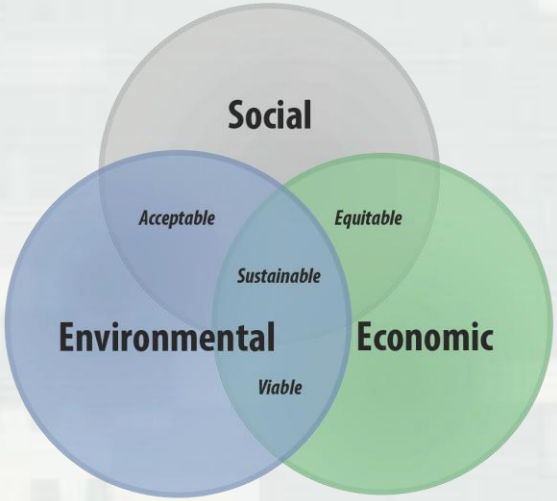
- More efficient, cost effective engineering and operational practices.
- More collaboration and cooperation, less unproductive conflict.
- Sustainable projects. Triple-win outcomes integrating social, environmental and economic objectives.

Engineering With Nature…

…the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental and social benefits through collaborative processes.

Key Elements:

- Science and engineering that produces operational efficiencies
- Using natural process to maximum benefit
- Broaden and extend the benefits provided by projects
- Science-based collaborative processes to organize and focus interests, stakeholders, and partners



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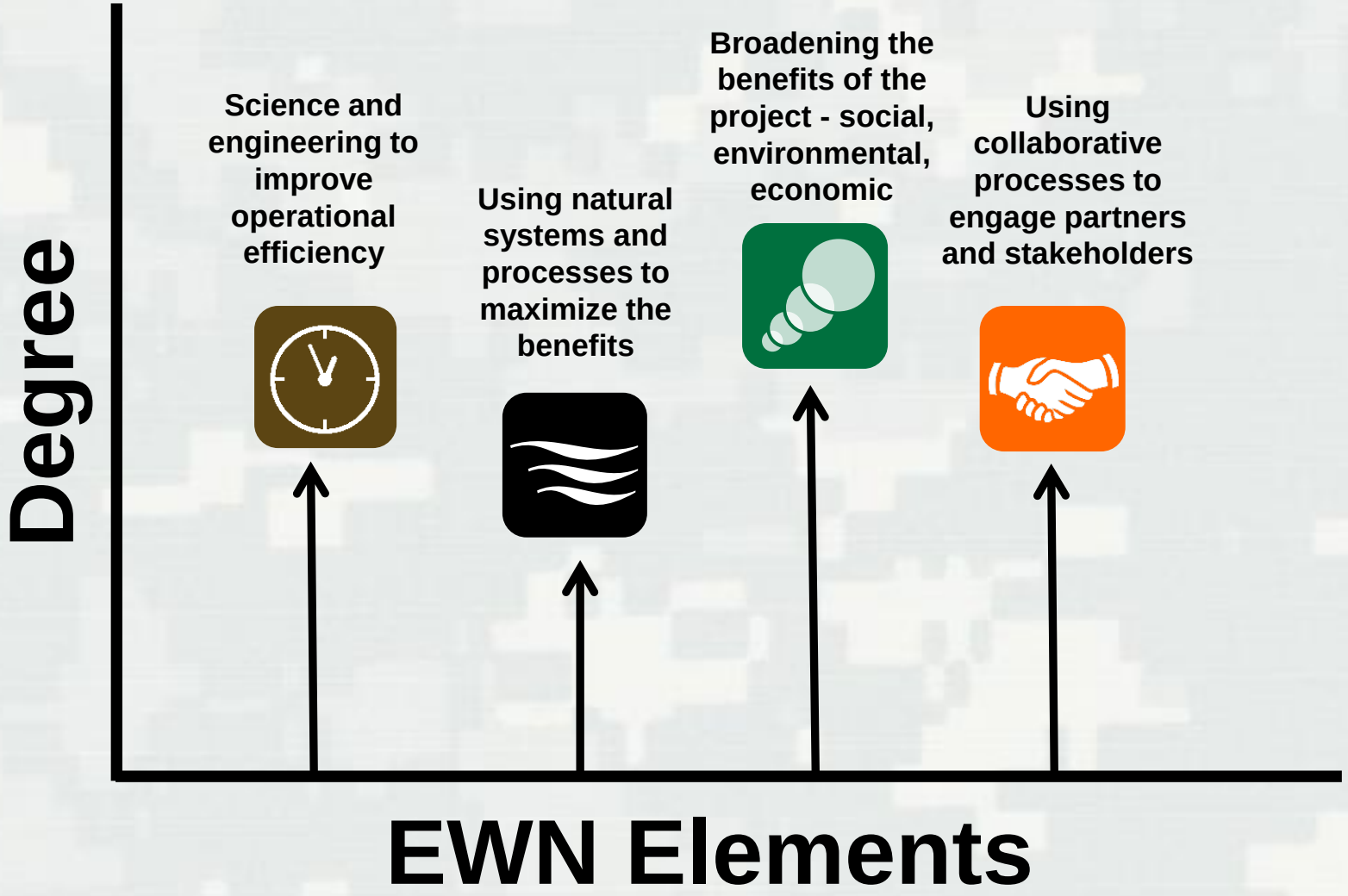
Engineering With Nature
Elements



Case Study #1

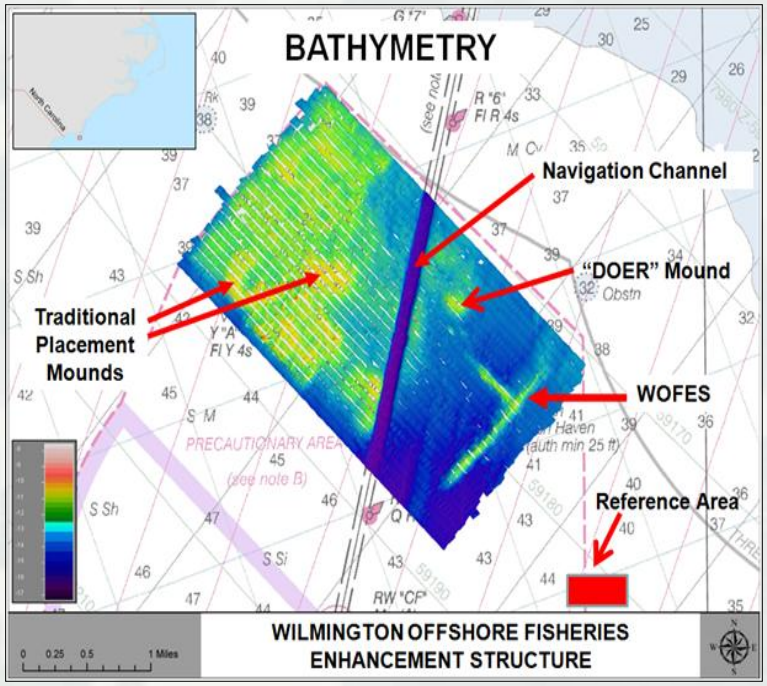
- Evia Island (Galveston Bay, TX)
- 6-acre island was constructed using sediment dredged during the deepening of the Houston Ship Channel in 1998
- Birds making use of habitat provided by the island
- Producing significant environmental benefits

Case Study #2

- Horseshoe Bend Island Creation along the Atchafalaya River (Morgan City, LA)
- As placement sites continue to become exhausted, there was a need for more creative placement alternatives in the Gulf Coast.
- In 2002, strategic placement of the sediment dredged from Horseshoe Bend occurred at the mid-river open water placement area.
- Strategic placement of between 0.5 to 1.8 million cubic yards of sediment was conducted every 1-3 years developing an ~35 ha island mid-river.
- Producing significant environmental and economic benefits

Case Study #3

- Wilmington Offshore Fisheries Enhancement Structure (Wilmington, NC)
- Created in 1994-1997 from 764,600 cubic meters of limestone dredged as part of the Wilmington channel deepening
- Located three nautical miles off of the mouth of the Cape Fear River in North Carolina
- The location and design of the reef involved extensive participation by stakeholders, and the North Carolina Department of Environment and Natural Resources supported the project as a local sponsor.
- Produced significant social benefits as a popular destination for fishing tournament participants



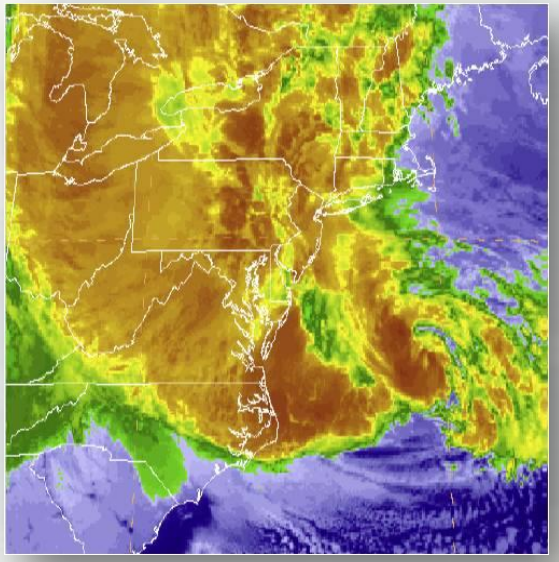
EWN Status

- *Engineering With Nature* initiative started within USACE Civil Works program in 2010. Over that period, we have:
  - Engaged across USACE Districts (23), Divisions, HQ; other agencies, NGOs, academia, private sector, international collaborators
    - Workshops (>20), dialogue sessions, project development teams, etc.
  - Implementing strategic plan
  - Focused research projects on EWN
  - Field demonstration projects
  - Communication plan
  - Awards
    - 2013 Chief of Engineers Environmental Award in Natural Resources Conservation
    - 2014 USACE National Award-Green Innovation
    - 2015 Western Dredging Association Environmental Excellence Award

Hurricane Sandy

Storm Impacts and Damages:

- **Human**
  - 286 people killed (159 in the US)
  - 500,000 people affected by mandatory evacuations
  - 20,000 people required temporary shelter
  - Extensive community dislocations – continuing today in some areas
- **Economic**
  - $65B in damages in the U.S.
  - 26 states affected (10 states and D.C are in the NACCS study area)
  - 650,000 houses damaged or destroyed



http://www.nad.usace.army.mil/compstudy

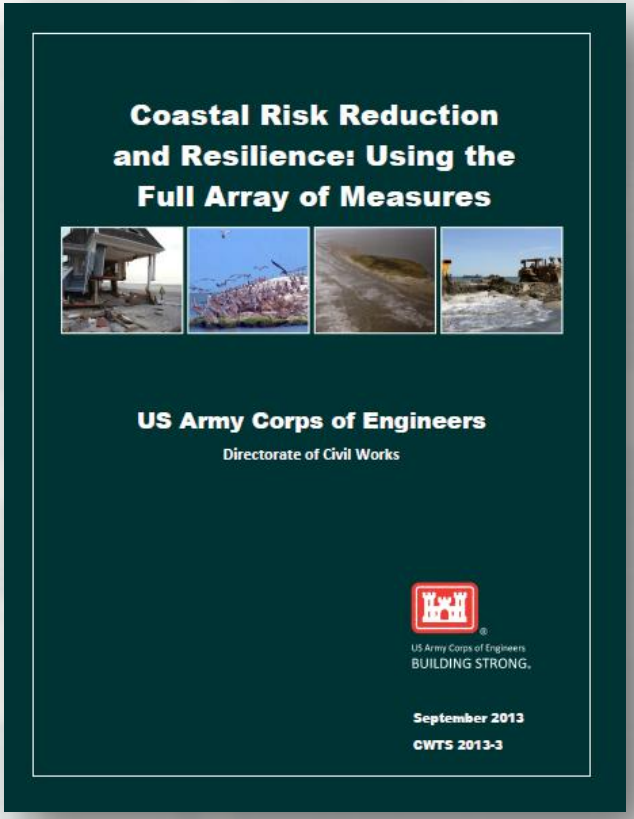
In the Context of Coastal Resilience…

- What opportunities are there for achieving better alignment of natural and engineered systems?
  - Can improved alignment reduce risks to life and property?
  - What range of services can be produced through such alignment?
  - What are the science and engineering needs in order to achieve better alignment?

Sustainable Solutions Vision: "Contribute to the strength of the Nation through innovative and environmentally sustainable solutions to the Nation's water resources challenges."

Systems: Coastal Risk Reduction and Resilience

"The USACE planning approach supports an ***integrated approach*** *to reducing coastal risks and increasing human and ecosystem community resilience through a combination of* ***natural, nature-based, non-structural and structural measures****. This approach considers the engineering attributes of the component features and the dependencies and interactions among these features over both the short- and long-term. It also considers the* ***full range of environmental and social benefits*** *produced by the component features."*



Natural and Nature-Based Infrastructure at a Glance

GENERAL COASTAL RISK REDUCTION PERFORMANCE FACTORS:
STORM INTENSITY, TRACK, AND FORWARD SPEED, AND SURROUNDING LOCAL BATHYMETRY AND TOPOGRAPHY

Dunes and Beaches

Benefits/Processes

Break offshore waves

Attenuate wave energy

Slow inland water transfer

Performance Factors

Berm height and width

Beach Slope

Sediment grain size and supply

Dune height, crest, width

Presence of vegetation

Vegetated Features: Salt Marshes, Wetlands, Submerged Aquatic Vegetation (SAV)

Benefits/Processes

Break offshore waves

Attenuate wave energy

Slow inland water transfer

Increase infiltration

Performance Factors

Marsh, wetland, or SAV elevation and continuity

Vegetation type and density

Oyster and Coral Reefs

Benefits/Processes

Break offshore waves

Attenuate wave energy

Slow inland water transfer

Performance Factors

Reef width, elevation and roughness

Barrier Islands

Benefits/Processes

Wave attenuation and/or dissipation

Sediment stabilization

Performance Factors

Island elevation, length, and width

Land cover

Breach susceptibility

Proximity to mainland shore

Maritime Forests/Shrub Communities

Benefits/Processes

Wave attenuation and/or dissipation

Shoreline erosion stabilization

Soil retention

Performance Factors

Vegetation height and density

Forest dimension

Sediment composition

Platform elevation

Natural and Nature-Based Features Evaluation and Implementation Framework

ORGANIZATIONAL ALIGNMENT

EVALUATION

IMPLEMENTATION

Iterate as Needed

Identify and Organize Stakeholders, Partners and Authorities

Define Physical and Geomorphic Setting

Assess Vulnerability and Resilience

Identify NNBF Opportunities
- Formalize NNBF Objectives
- Identify NNBF Alternatives
- Define NNBF Performance Metrics

Evaluate NNBF Alternatives
- Tier 1
- Tier 2
- Tier 3

Advance through Tiers as Appropriate

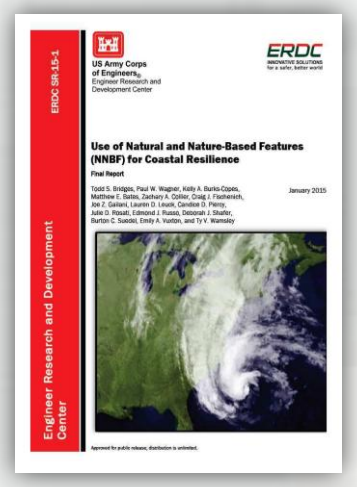
Select NNBF Alternatives

Design Implementation Plan: Elaborate Operational and Engineering Practices

Implement NNBF Alternative

Monitor for Performance and Assess Ecosystem Goods and Services

Feedback

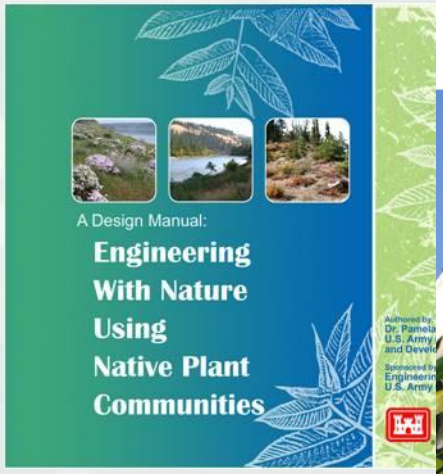


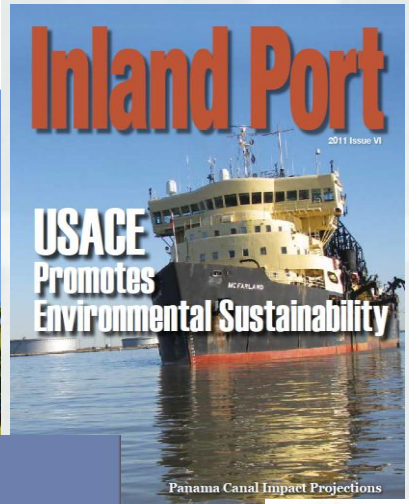
Coastal Resilience: The Environment, Infrastructure, and Human Systems

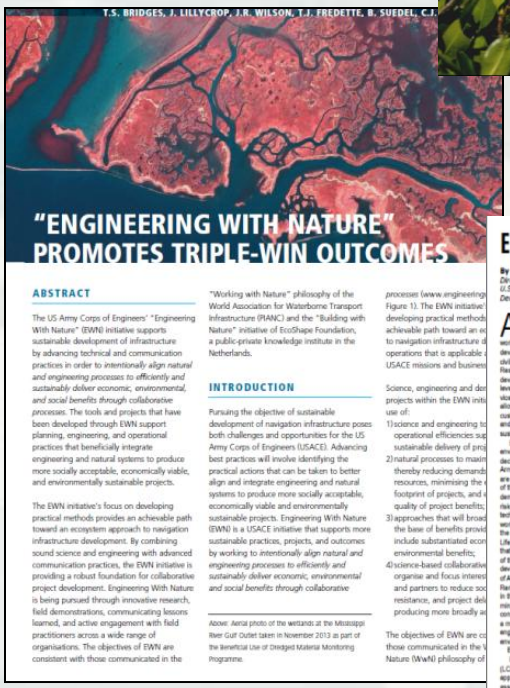
- USACE was the primary sponsor and host (USEPA and USDOE were co-sponsors)
  - Dr. Todd Bridges, Conference Chair
  - Ms. Cynthia Banks, Conference Organizer
- 85 participants from 8 countries (Barbados, Fiji, Mexico, The Netherlands, South Africa, South Korea, United Kingdom, and United States)
  - Diversity of organizational perspectives:
    - USACE, NOAA, USEPA, USFWS, OMB, CEQ, DOE, US Navy, Treasury Department, State Department, TNC, AAPA, Water Institute of the Gulf, National Wildlife Federation, Great Lakes Dredge & Dock Company, Environ Corp., Dewberry, several universities, and many other organizations
- Conference consisted of a series of plenary presentations and panel discussions
  - Share information about science and engineering relevant to coastal resilience

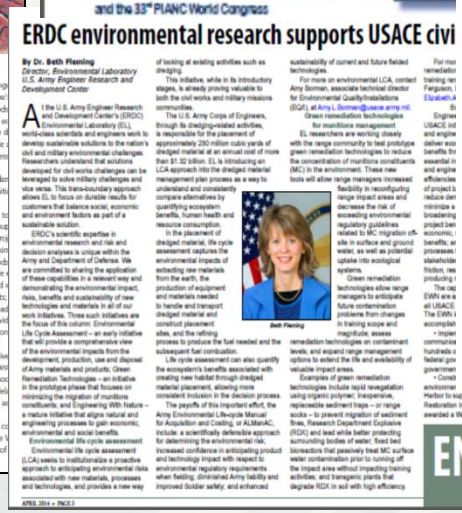
The audio and visuals for each presentation are at:
http://el.erdc.usace.army.mil/ewn/workshop.cfm?List=14MayCR

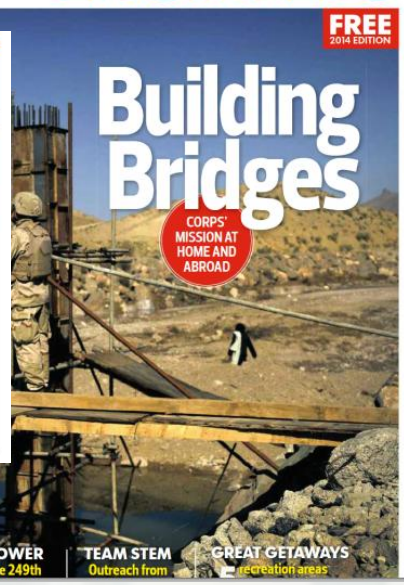
Communication

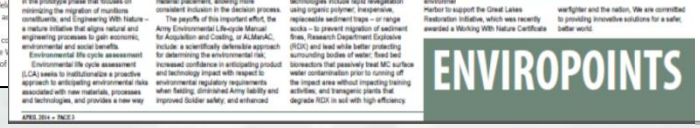




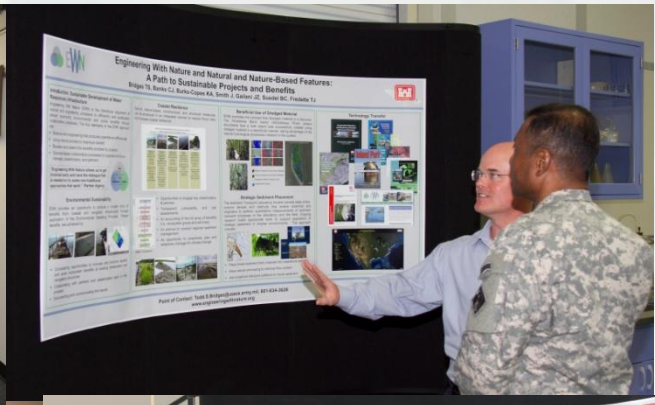


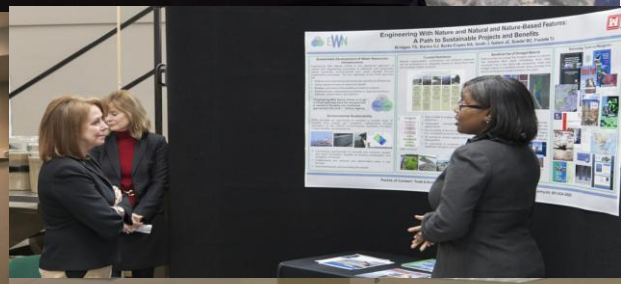


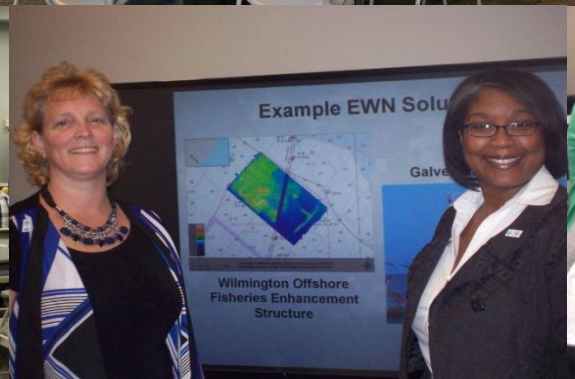




Engagement and Solution Co-Development







2013 EWN Action Demonstration Projects

- Sediment Retention Engineering to Facilitate Wetland Development (San Francisco Bay, CA)
- Realizing a Triple Win in the Desert: Systems-level Engineering With Nature on the Rio Grande (Albuquerque, NM)
- Atchafalaya River Island and Wetlands Creation Through Strategic Sediment Placement (Morgan City, LA)
- Portfolio Framework to Quantify Beneficial Use of Dredged Material (New Orleans and New England)
- Engineering Tern Habitat into the Ashtabula Breakwater (Ashtabula, OH)
- Living Shoreline Creation Through Beneficial Use of Dredged Material (Duluth, MN)
- A Sustainable Design Manual for Engineering With Nature Using Native Plant Communities

2014 EWN Action Demonstration Projects

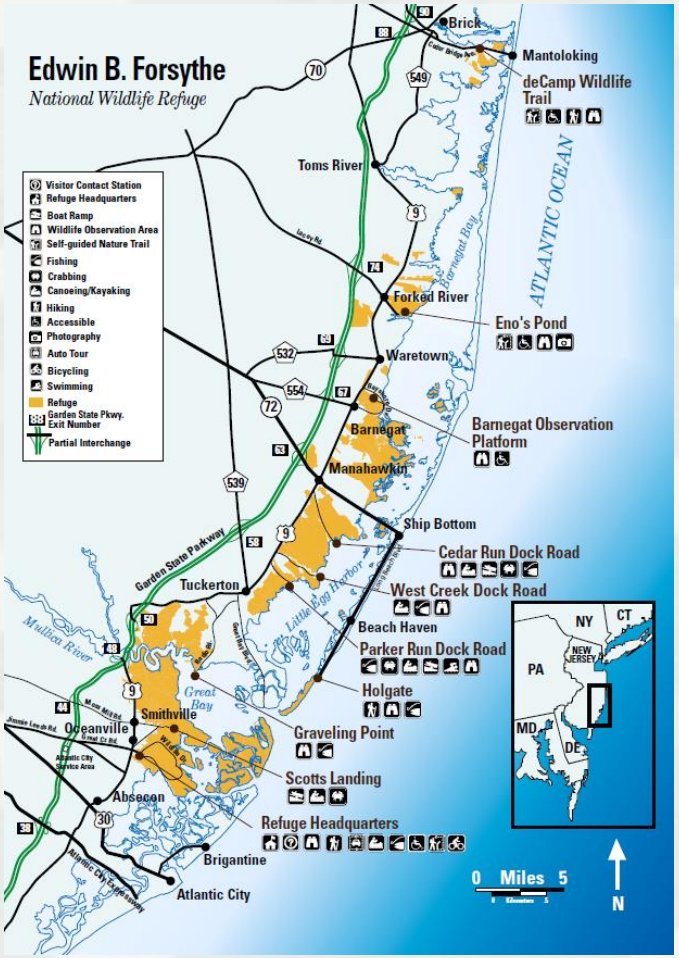
- Landscape Evolution of the Oil Spill Mitigation Sand Berm in the Chandeleur Islands, Louisiana
- Guidelines for Planning, Design, Placement and Maintenance of Large Wood in Rivers: Restoring Process and Function (Collaboration with BoR)
- The Use and Value of Levee Setbacks in Support of Flood Risk Management, Navigation and Environmental Services (a strategy document)
- Strategic Placement of Sediment for Engineering and Environmental Benefit (an initial guide to opportunities and practices)

USACE *Engineering With Nature* Across USACE

- Collaborating with Philadelphia, Detroit, San Francisco, New Orleans Districts on using sediment to enhance coastal resilience
- Galveston and Buffalo Districts serving as “proving grounds” for district-wide integration of EWN principles and practices

Forsythe National Wildlife Refuge

- Forsythe NWR: >40,000 acres of wetlands and other habitat in coastal NJ
- Objective: Enhance ecosystem resilience through engineering and restoration
- Means: Apply EWN principles and practices

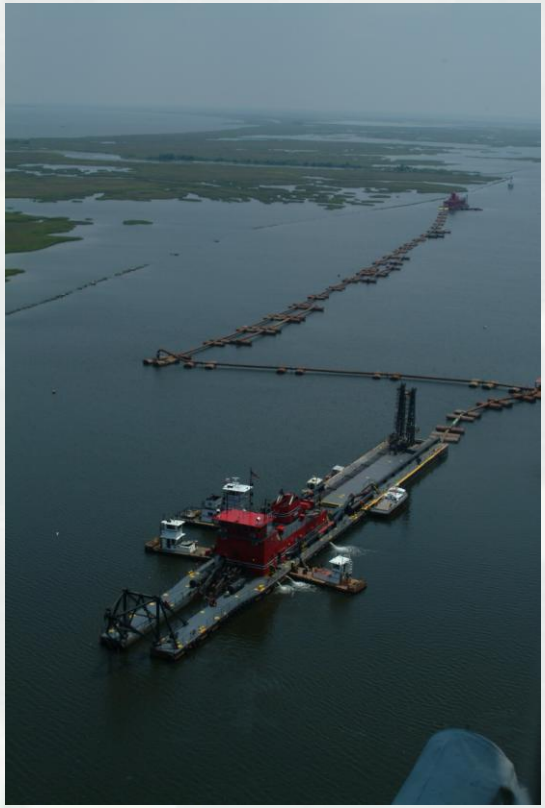


Science, Engineering, Technology Research Targets

- Advance understanding of important, fundamental processes
  - E.g., sediment transport through wetlands, environmental goods and services provided by engineered features, engineering performance of NNBF
- Improved modeling systems that engage users, stakeholders and decision-makers
  - E.g., rapidly deployed, visual interfaces to engage stakeholders in the process, amenable to “what if” evaluation
- Reliable, cost-efficient monitoring technologies for measuring system evolution and infrastructure/feature performance
- Demonstration/pilot project opportunities to innovate, evaluate, and learn at relevant field scales
  - Facilitating necessary collaboration
  - Evolving organizational culture and practice
  - Producing credible evidence of success

Creating Value by Engineering With Nature

- Value arguments resonate
- Moderate the hyper-focus on environmental risks/impacts from conventional infrastructure
  - NNBF can produce multiple benefit streams
  - There are potentially valuable allies in “unlikely” places
- Need for complementing sustainability policies with education and research



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